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This paper discusses the theory and presents examples of free-association norms. Examples from several categories of free-association data are given. Their use in experiments on cultural characteristics of the associative structures of words are also explained. A graph of the relationship between primary and secondary associations and tables of associations and probability hierarchies are included. These tables are explained in the text of the paper and illustrated in the appendix. A bibliography is also included. (WD)

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Free-Association Norms and Associative Structure

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A very good demonstration of the effects of cultural word habits on the kinds of correct recall and misrecall to be expected after training on a short list of words was made two years ago (Bilodeau, Fox, and Blick, 1963). The essence of the procedure involved the use of a stimulus prompt or cue during the recall period to assist in the retrieving process. The recall stimulus was a word associated in various degree to the word presented during training, but a word which had not been administered to S during training. The stimulus word used by E was chosen because of its particular properties of response evocation exhibited in tests of free association. The free-association test had been administered earlier, elsewhere, and to other people. Hence, the findings showed cultural characteristics of associative structures of words to be a means of predicting the probability of a correct retrieval or the probability of a particular misrecall.

A few examples from free-association data will make the above clear. My examples have been selected from Categories A, B, and C, classifications of associative structure which have considerable use in the design of experiments.

Category C

	$\frac{S_1}{\text{light}}$	$\frac{R_1}{\text{dark}}$	$\frac{R_2}{\text{bulb}}$	$\frac{R_{3-n}}{\text{bright, etc.}}$
p		.57	.06	.37

Above, dark is the primary associate of light and its probability [$p(R_1)$] equals .57, bulb is the secondary associate of light with $p(R_2)$ = .06, and bright and so on are the remaining associates in the response hierarchy. Their combined probability, which I call $p(R_{3-n})$, equals .37. If S were trained on bulb and tested for recall of bulb in the presence of light, we might expect that (a) bulb would appear more frequently than when light is not used, (b) when bulb is not recalled, dark might intrude in its place, and

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(c) if not dark intruding, then bright, etc. would. A Cat. C word is characterized as a stimulus where the value of $\underline{p}(R_1)$ is relatively high in association hierarchies.

Category B

In another case, as illustrated below, R_1 and R_{3-n} form less competition to recalling R_2 because the probability of R_2 is near maximum in the hierarchies.

	$\frac{S_1}{\text{ocean}}$	$\frac{R_1}{\text{water}}$	$\frac{R_2}{\text{sea}}$	$\frac{R_{3-n}}{\text{blue, etc.}}$
$\underline{p}$		.31	.30	.39

Here R_2 should be easier to recall than in the example of Cat. C. If R_2 is not recalled, then the intrusion is more likely to be an R_{3-n} and less likely to be an R_1 than for words from Cat. C. A Cat. B word in the norms is characterized as a stimulus word where $\underline{p}(R_2)$ is strong, though still less than that of the primary.

Category A

For Cat. A words, illustrated below, the $\underline{p}(R_2)$ and $\underline{p}(R_1)$

	$\frac{S_1}{\text{cheese}}$	$\frac{R_1}{\text{cracker}}$	$\frac{R_2}{\text{milk}}$	$\frac{R_{3-n}}{\text{cake, etc.}}$
$\underline{p}$		.11	.10	.79

are low, while $p(R_{3-n})$ is high. In this case, R_2 should be recalled about as well as in C above, but R_{3-n} intrusions should predominate over primaries. A Cat. A word is characterized as a stimulus word where $\underline{p}(R_{3-n})$ is near maximum value in the cultural norms.

The Russell-Jenkins (1954) free-association norms were analyzed by Bilodeau, Fox, and Blick (1963) as suggested by my examples of categories above. A strong relationship between the primaries and secondaries was quickly discovered. This relation (eta equals .65) can be seen after careful examination of the 100 dots in the lower part of Fig. 1, a most important law being found. When $\underline{p}(R_1)$ is very low or very high, $\underline{p}(R_2)$ is low, as it must be; when $\underline{p}(R_1)$ is of moderate strength, $\underline{p}(R_2)$ reaches its maximum values. The best chance

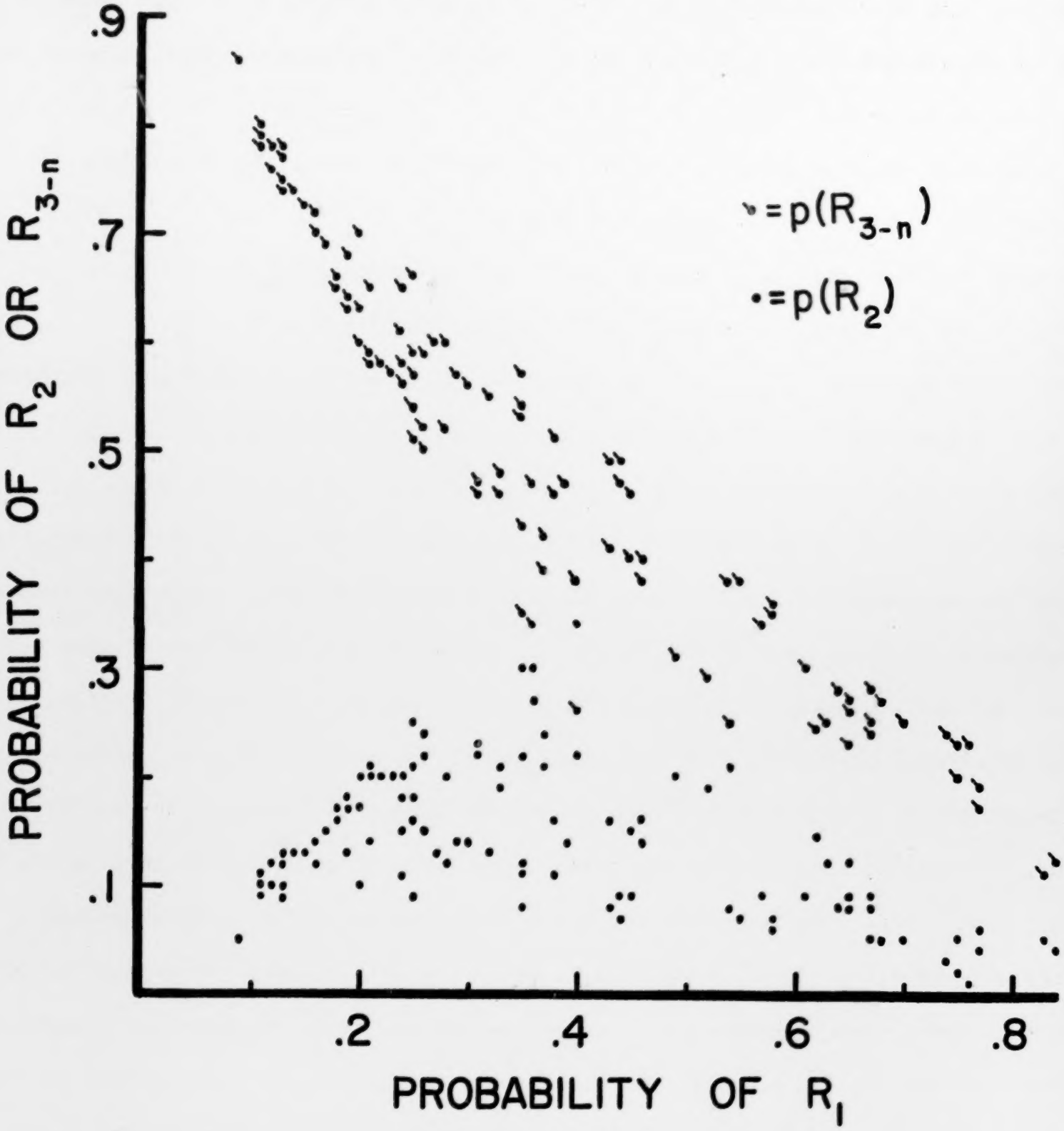

Fig. 1. Scatter plot showing the relationship between $\underline{p}(R_2)$ or $\underline{p}(R_{3-n})$ and the independent variable, $\underline{p}(R_1)$ in the Russell-Jenkins hierarchies of associative responses. Note that $\underline{p}(R_2)$ rises in magnitude and reaches a maximum when $\underline{p}(R_1)$ is about .35 (after Bilodeau, Fox, & Blick, 1963).

of responding with R_2 is with $\underline{p}(R_1)$ in the neighborhood of .35. A strong and necessarily negative relationship between $\underline{p}(R_1)$ and the probability of responses 3 to n is shown by the 100 dots with tails in Fig. 1.

To summarize, three kinds of words or categories stand out in the Russell-Jenkins norms.

Category A: Low $\underline{p}(R_1)$, low $\underline{p}(R_2)$, and high $\underline{p}(R_{3-n})$

Category B: Moderate $\underline{p}(R_1)$, maximum $\underline{p}(R_2)$, and moderate $\underline{p}(R_{3-n})$

Category C: High $\underline{p}(R_1)$, low $\underline{p}(R_2)$, and low $\underline{p}(R_{3-n})$

When used for stimulating recall, Cat. A words have maximized the incidence of responses 3 to n, Cat. B produced the most R_2s, and Cat. C produced the most R_1s.

I can give only three examples of recent research with categories from the Tulane laboratory. The first design varied Categories and Duration of Rest; after a brief rest, the recall scores resembled a recall process, but after a long rest, the process resembled free association (Bilodeau and Blick, 1965). In another study, primary words were put into the first list and secondary words were used in the second list (Blick, 1965). The primaries interfered enormously with the retrieval of the secondaries, the effect being accounted for by the strength of the primary in free-association norms. In the third study, the Ss were required to free associate as an activity interpolated between training and recall (Fox, 1964). As hypothesized, the individuals interpolated free associate interferes with recall or facilitates recall, depending on the normative properties of the stimulus. In these three studies then, and others coming along, we are gaining control over the individual subject and the word he utters. Of course, the use of norms is not restricted to learning and recall tasks but may be generalized to any word-communication task (Rosenberg and Cohen, 1964).

The need for associative norms has been growing rapidly as a glance at recent journals of experimental psychology will show. During the last decade, the Russell-Jenkins data (1954) have been frequently used. Similar norms by Palermo and Jenkins (1964) were published last year. Riegel just published norms on restricted association (1965). These norms specify responses and frequency of response to common stimulus words. They constitute an important source of raw data for investigators in psychometric and experimental traditions.

Another useful set of associative structures was published a few months ago by Bilodeau and Howell (1965). Newer, improved, and different associative probability structures are expected to be discovered in these norms and it is this book of norms which I wish to describe below. For discrete association, S responded only once to the stimulus word; for continued association, S responded three times to the stimulus word, the stimulus being administered three times.[2] The continued norms may yield greater accuracy in estimating response arousal through the probability with which a given response is found in the first three responses of Ss. A secondary response is not necessarily weak because its probability is low in Discrete association. It might have a considerable probability should S be given another opportunity to respond. A low probability for R_2 in discrete association does not necessarily mean that it does not compete strongly even at the time the primary is emitted.

The program for Discrete norms called for 324 Ss and that for Continued, 972 Ss. A small booklet presented the task. The stimuli were 180 in number, 45 being the Index words or Cat. A, B, and C words I described earlier, the remainder the primary, secondary, and tertiary responses--or the top of the hierarchy. Because the stimulus words were taken from the top of the hierarchies, the new norms will show how related words lead to each other and to words in common.

Tables for discrete association: Probability hierarchies for the 45 Index words in Discrete association were calculated, one sample being shown in the Appendix, page 48. Associates with p = .01 and not overlapping with other associates have been collected together and are shown on page 49 of the Appendix.

Index No. 2 on page 48, that is Whistle, Blow, Train, Noise, illustrates the reading of the table. Whistle arouses train (p = .14), blow, girl, etc. as well as loud (.06) and sound (.06). Blow, when used as a stimulus, arouses wind (p = .56), horn, hard, etc. The table shows how the analysis is arranged to feature hierarchical orders, overlapping associates, and high probability events such as $p(R_1)$. On page 49 of the Appendix the matrix at the bottom shows some of the p .01 words for Whistle (bait, ball, bird, ... yell).

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This zero-one matrix shows that the R_1, R_2, and R_3 associates of Whistle do not evoke the p = .01 words just mentioned. The table contains only diagonal matrices whose diagonal element is 1 (yes), e.g. an identity matrix. The associate in question is evoked only once and only by one of the four stimuli.

Should two or more stimuli evoke the same associate and p = .01 for each, the phenomenon would have been seen on page 48. There were no such overlaps for Whistle though they do occur here and there for other Index words. Some p = .01 events are entered on page 48 in the Whistle matrix, however. In all such cases, another stimulus has evoked the associate in question with p>.01. By now it will have been seen that there are three kinds of uniqueness among associates, the type in the identity matrices (page 49) containing the largest number of elements.[3]

Finally, the Whistle matrix appears in the 2nd position among the 45 indices of the whole table (in the book) because the $p(R_1)$ for Whistle has rank 2. Thus, the pages are not ordered arbitrarily but according to an important property of the matrix, the dominant event (Bilodeau, Fox, and Blick, 1963). In the case of Whistle, its primary is weak, it is a Category A word, and it arouses a relatively large number of different words.

Tables for continued association: On page 50 of the Appendix the behavior of Whistle in Continued association is shown. As with the Discrete norms, the associates with p = .01 and not overlapping with others have been segregated and are collected elsewhere in order to organize these common elements of hierarchies. The most important difference between the Continued and Discrete hierarchy is that the three Continued associates (C_1, C_2, and C_3) are represented as columns. The words of an Index take up four consecutive pages.

Again I use Whistle as the Index and for an example in table reading. It arouses train, blow, noise, and so on, in the first opportunity; train, girl, tune, and so on, in the second opportunity; and girl, tune, stop, and so on, in the third opportunity. The zero-one matrix (100) at the top on page 51 contains the p = .01 words of C_1 with no instances in common with C_2 and C_3. Matrices (010) and (001) represent those associates strictly unique to C_2 and C_3, respectively. Those associates which overlap appeared in the previous table as (111), (110), (101), or (011).

Tables for discrete and continued networks of association: The entries on page 52 of the Appendix contain information already presented in the earlier ones, the information being reorganized for better access. Here, the associative networks for Discrete and Continued association for the top four terms of the hierarchies are given. The ps for Discrete association are given under Column D, those for Continued under C_1, C_2, C_3.

Again Whistle, Blow, Train, Noise (Index No. 2 in the upper right) is used as my example.[4] S_0 = Whistle, R_1 = Blow, R_2 = Train, and R_3 = Noise, so that 01 means, using Whistle as a stimulus and Blow as a response, the p of Blow in Discrete association is .13; in the first Continued association it is .11, in the second it is .03, and in the third it is .04. The notation 10 means using Blow as a stimulus and Whistle as a response. The whol network from 01 to 32 is represented under Column SR (stimulus response).

To conclude, I have shown that the new norms contain processed, organized data still raw enough to provide new information on associative laws for those readers who will wish to process them further. In my own laboratory they are being used extensively in studies of verbal retention (Blick, 1965; Bilodeau and Blick, 1965; Fox and Bilodeau, 1966). My major purpose in presenting these norms here is to encourage further examination of the characteristics they contain and the experimental variation of these characteristics for word-communication studies.

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Footnotes

1. Currently on Leave of Absence granted by the Tulane University Council on Research and serving as Visiting Professor at the University of Washington. This paper reviews some of the research performed under Contract Nonr-495(10) between the Office of Naval Research and Tulane University.

2. A comparison of the methods was made earlier by Rosen and Russell (1957), and by Cofer (1958).

3. At the foot of the matrices on the page 48 are found (a) the number of words with p = .01 entered in the column above it; (b) the total number of words with p = .01, a figure obtained by summing the corresponding values from pages 48 and 49; (c) the total number of different words (W) evoked by the stimulus; and (d) the N or total number of subjects responding with a word.

4. Whistle in Discrete association arouses blow (p = .13), train (p = .14), and noise (p = .06). In Continued association, the corresponding ps are .11, .17, .10 the first time; .03, .17, .01 the second time; and .04, .03, .04 the third time.

Appendix

Sample Pages of Probability Hierarchies in Discrete and Continued Association

2. Whistle, Blow, Train, Noise

	Whistle	Blow	Train	Noise
WHISTLE				
train	.14	-	-	-
blow	13	-	-	-
girl	11	-	-	-
noise	6	-	2	2
dog	4	-	-	-
call, happy, music	3	-	-	-
cop, lips, sing, siren, song, stop, work	2	-	-	-
BLOW				
wind	-	56	-	1
horn(s)	-	11	1	1
hard	-	6	-	-
nose	-	4	-	1
suck	-	4	-	-
breeze	-	3	-	-
up	-	2	-	-
TRAIN				
track(s)	-	-	12	-
car(s)	-	-	10	1
whistle	-	1	6	-
plane, travel	-	-	6	-
bus, caboose, smoke	-	-	5	-
engine	1	-	4	-
boat	-	-	4	-
fast, go, railroad	-	-	3	-
choo choo, locomotive, ride, transportation, truck	-	-	2	-
NOISE				
loud	6	-	-	23
sound(s)	6	-	-	14
quiet	-	-	-	8
racket	-	-	-	5
silence	-	-	-	4
ear, gun, quite	-	-	-	3
crash, din, radio	-	-	-	2
Prob. blanks	.01	.01	.01	-
No. .01 words above	1	1	1	4
Total No. .01 words	21	14	19	33
No. of words (W)	38	21	38	45
No. of responses (N)	107	107	107	108

1. Yellow, Color, Green, Blue

(1000) balloon, beautiful, book, canary, Chinese, dingy, dress, frighten, hair, jaundice, lemon, pale, ribbon, sign, teeth, three, tiger

(0100) beauty, blonde, pictures, pretty, race, see, skin, spectrum

(0010) bay, clover, giant, go, horn, land, lettuce, money, pastures, pea, people, seen, ugly

(0001) Air Force, Chris, clothes, coat, cool, day, flag, grey, jeans, mood, red and white, shade, suit, true

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2. Whistle, Blow, Train, Noise

(1000) bait, ball, bird, cat, hum, hymn, noon, pig, police, shout, shrill, softly, swan, toot, toy, tune, wolf, women, wow, yell

(0100) balloon, beneath, billows, blew, breath, cold, exhale, fist, hit, Joe, puff, still, under

(0010) B & O, black, black noisy, brain, diesel, long, motion, move, noisy, rail, rain, robbery, speed, station, strong, toy, transport, wheel

(0001) band, bang, bar, barracks, bathroom, bay, big, chaos, commotion, deaf, distrubance, drum, eyes, face, frighten, generator, headache, hear, heat, load, lockers, maker, morning, mouth, pain, person, shut up, silent, smell

For additional prob. .01 words see page 48.

5a. WHISTLE, Blow, Train, Noise

	C_1	C_2	C_3
train	.17	.17	.03
blow	11	3	4
noise	10	1	4
loud	4	3	2
sing	4	2	2
work	3	2	1
song	2	2	1
shrill, siren	2	1	1
talk, tweet	2	-	-
girl(s)	6	9	7
tune	7	8	6
sound	3	4	1
horn	2	3	-
music	1	3	2
cop	-	3	-
toot	1	2	-
policeman, ship	-	2	1
hear	-	2	-
stop	3	3	5
happy	3	1	5
dog	1	3	4
bird(s)	1	-	4
boat	-	1	4
call, steam, wolf	1	1	2
fire	1	-	2
wind	-	1	2
police, shriek	-	-	2
lips, note	1	1	-
mouth	1	-	1
clean, fire drill, warning	-	1	1
Prob. blanks	.04	.05	.10
No. .01 words above	11	14	11
Total No. .01 words	15	26	29
No. of words (W)	32	44	49
No. of responses (N)	101	100	95

5a. WHISTLE, Blow, Train, Noise

WHISTLE

(100) at, bell, shout, soda

(010) black, car, fall in, for, fun, hum, long, lunch, medium, person, so, yell

(001) attract, ball, boy, cat call, drill, fire engine, go, Lackland, pipe, retreat, shiny, signal, snore, soft, steamboat, teeth, to, wow

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5b. Whistle, BLOW, Train, Noise

BLOW

(100) blast, explode, fight, hot, slow, train, windy

(010) belt, blower, bomb, claringet, draw in, fast glass, grow, jump, loud, lungs, sail, sky, still, threw, toot, tornado, under

(001) bag, beneath, blare, blown, boy, bugle, clouds, dryer, dust, easy, exhaust, faster, French horn, hair, heart, in, mature, news, noise, over, paint, pass, people, pipe, remote, sailboat, shell, ship, smoke, snow, wint

1. Yellow, 2. Whistle, 3. Head, 4. Cheese

S_0	Yellow
R_1	Color
R_2	Green
R_3	Blue

SR	D	C_1	C_2	C_3
01	.09	.16	.07	.06
02	09	06	08	05
03	06	06	02	06
10	03	01	02	03
12	06	04	07	09
13	26	21	14	16
20	06	07	05	02
21	04	10	10	02
23	11	11	05	02
30	00	00	02	02
31	10	17	05	05
32	04	07	03	02

S_0	Whistle
R_1	Blow
R_2	Train
R_3	Noise

SR	D	C_1	C_2	C_3
01	.13	.11	.03	.04
02	14	17	17	03
03	06	10	01	04
10	01	02	02	00
12	00	01	00	00
13	00	00	00	01
20	06	06	06	06
21	00	00	00	00
23	02	04	04	04
30	00	00	00	00
31	00	00	00	00
32	00	02	00	01

S_0	Head
R_1	Foot
R_2	Hair
R_3	Shoulder

SR	D	C_1	C_2	C_3
01	.06	.06	.02	.01
02	13	05	14	07
03	11	06	05	00
10	01	00	00	00
12	00	00	00	00
13	00	00	00	00
20	16	11	02	02
21	00	01	00	00
23	00	00	00	00
30	05	06	01	04
31	00	00	00	00
32	00	00	01	00

S_0	Cheese
R_1	Cracker
R_2	Milk
R_3	Cake

SR	D	C_1	C_2	C_3
01	.06	.01	.06	.02
02	08	14	07	08
03	15	14	03	02
10	06	03	04	06
12	03	01	03	00
13	00	00	00	01
20	00	01	00	00
21	00	00	00	00
23	00	00	00	00
30	00	00	00	00
31	00	00	00	00
32	02	00	00	01